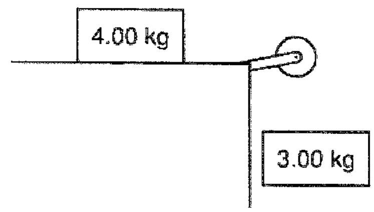
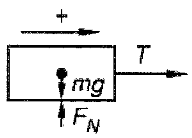
Solving Two Tension Force Problems

<u>Problem A</u> 4.00-kilogram block rests on a frictionless table top, as shown. This block is connected to a 3.00-kilogram block that passes over a massless, frictionless pulley, as shown. Find the acceleration of the blocks and the tension in the rope.

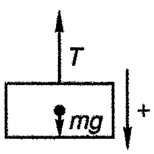


To solve this problem we will write a $\Sigma = ma$ equation for both blocks. Then we will solve this pair of simultaneous equations. First we will draw a free-body diagram for the 4.00-kg block and write the equation for this block. We will let the +x direction be positive for this equation, as we indicate with the arrow and the + sign below. The tension T is the only force on the block in the x direction.



	$T = ma_1$	$\Sigma F_x = ma_x$
(a)	$T = 4.00a_1$	substituted

The 4.00-kilogram block does not move vertically, so a $\Sigma = ma$ equation is not required. Now we draw the free-body diagram for the 3.00-kilogram block. There are two forces in the y direction. We remember that in this problem the positive y direction is down, as we indicate with the arrow and the plus sign.



	$mg - T = ma_2$	$\Sigma F_y = ma_y$
	$(3.00)(9.81) - T = (3.00)(a_2)$	substituted
(b)	$29.43 - T = 3.00a_2$	simplified

For this example, we have carefully distinguished the accelerations of the blocks by denoting them as a_1 and a_2. Since we have chosen our positive directions carefully, the acceleration of both blocks are positive and have the same magnitude, and our distinction of the accelerations is unnecessary. In the future, we will denote the acceleration of both blocks in two body tension problems simply as a.

Now we will replace T in equation (b) with 4.0 a from equation (a)

$$29.43 - T = 3.0\,a \qquad \textit{Equation (b)}$$

$$29.43 - (4.0\,a) = 3.0\,a$$

$$29.43 = 7.0\,a$$

$$a = 4.204\ m/s^2$$

Now we use equation (a) to find T

$$T = 4.0\,a \qquad = 4.0\,(4.204) \qquad = 16.82$$

We did not bother to use units in the $\Sigma = m\,a$ equations because we remember that if we use SI units carefully, acceleration will be in meters per second per second and force will be in newtons.